

Synopsis V1.0
Proton Single Event Latchup Testing of the
AD7664 Analog Devices Analog to Digital Converter

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I. Introduction

This study was undertaken to determine the proton latchup susceptibility AD7664 Analog Devices Analog to Digital Converter. The device was monitored for latchup induced high power supply currents by exposing it to a proton beam at the Indiana University Cyclotron Facility (IUCF).

II. Devices Tested

The devices were manufactured by Analog Devices, Inc and all devices were characterized prior to exposure. The five devices tested were from date code 0110.

III. Test Facility

Facility: Indiana University Cyclotron Facility

Proton Energy: 189.9 MeV incident on device structure

Flux: 1.1×10^9 to 1.5×10^9 protons/cm²/s.

IV. Test Methods

Temperature: room temperature

Test Hardware:

The Test Layout for the AD7664 Latchup Experiment (See Figure 1) consists of a multi-channel power supply, a digitizing oscilloscope, Digital Multimeters (DMM's), and a function generator. Control of all test equipment was performed remotely via General Purpose Interface Bus (GPIB) with a Laptop computer as master. All relevant equipment connections to Device Under Test (DUT) board, are made using RG-58 BNC cable and scope probes. The DUT board is made up of two sections, Bias/Configuration pertaining to all devices under test and Latchup monitoring for high speed shut down and current signature capture.

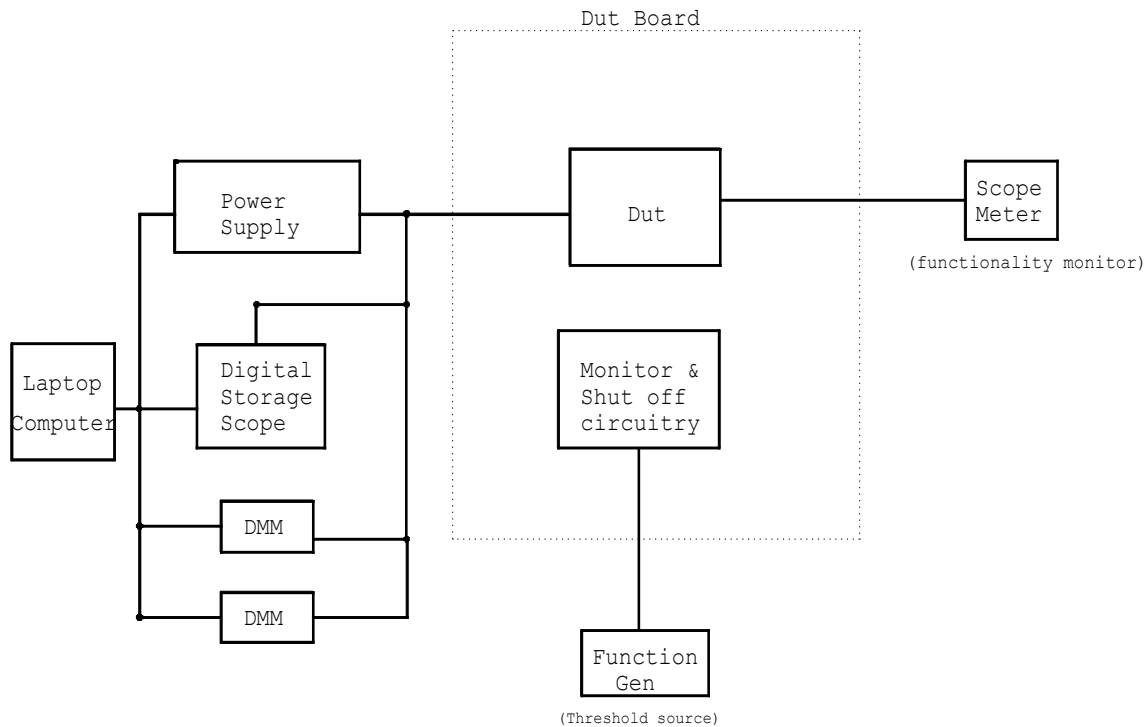


Figure 1. Block diagram for overall test setup for the AD7664.

Bias conditions for the AD7664 (See Figure 2) consisted of separate 5-volt DC supplies for A_{vdd} and D_{vdd}/O_{vdd} . Device configuration included operating in the "Warp" mode (500kHz conversion rate), parallel data interface, and straight binary mode. A conversion clock was produced by an on board 555 Timer, which provided a TTL compatible output in order to achieve the maximum conversion rate allowable. The analog source is a variable DC supply, capable of supplying the entire range of voltages from 0 to 2.5 volts. Throughout the experiment, a 1-volt DC input was applied to the converter.

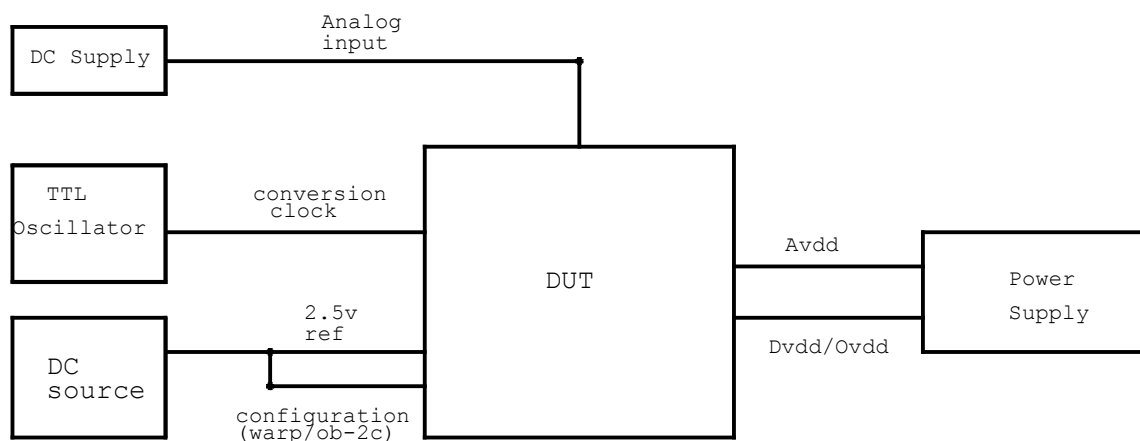


Figure 2. DUT biasing and configuration block diagram.

The design used for monitoring nominal to latchup current conditions is shown in Figure 3. The monitoring system begins with 1 ohm shunt resistors for measuring a

voltage representation of the current drawn at the Analog and Digital Power pins. Threshold and shut off circuits, utilizing difference amplifiers and voltage comparators, were used to trigger device power shutoff once the device current exceeded a predetermined value.

The voltage drop across the 1 ohm shunt resistor is amplified by a factor of approximately 5 for Dvdd/Ovdd and 1 for Avdd in order to increase signal to noise ratio and to utilize a single threshold setting for both currents. Once the amplified shunt voltage value eclipsed the threshold level, the voltage comparator produced a signal, which via some control logic, would switch a relay that disconnected source power to both power inputs in a time period of approximately 50 microseconds.

Test points were provided for a digitizing scope and a pair of DMM's. The Digital Scope captured and saved the real time current signature during post and pre latch up conditions (sub-microsecond resolution), while the DMM's were used to record strip charts of currents (millisecond resolution) during the entire irradiation run.

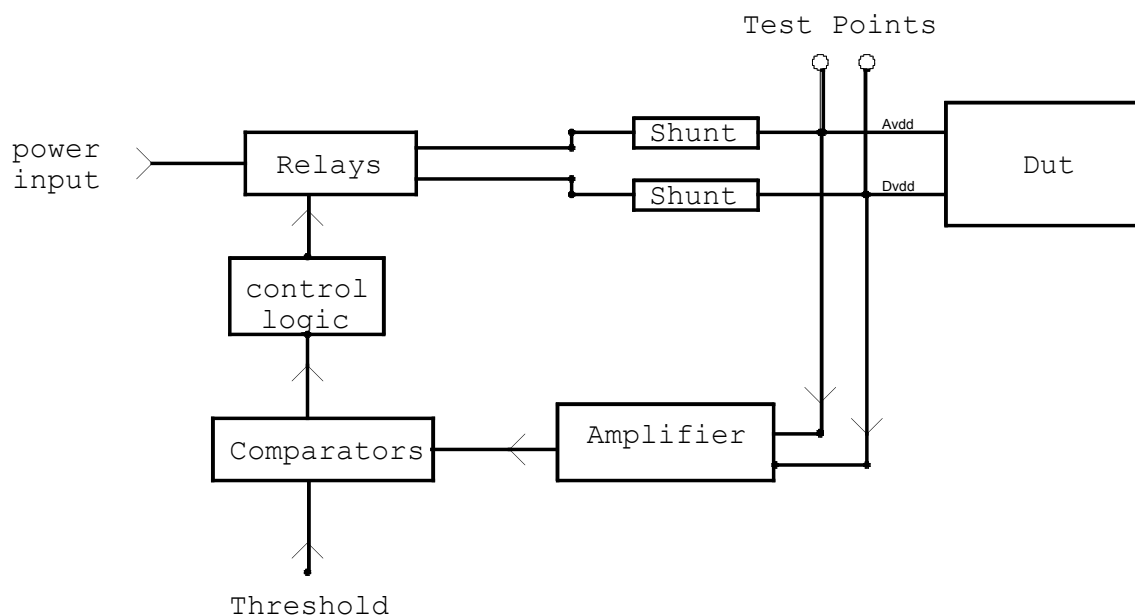


Figure 3. Latchup monitoring and protection block diagram.

Software:

Customized LABVIEW[®] software provided a user interface to control signals to the DUT. The software also automatically monitor supply currents and generated a file history.

Test Techniques:

The AD7664 was tested for latchup susceptibility by placing the Device Under Test (DUT) in the proton beam and monitoring the latchup protection system for initiation. If the protection system initiated shutdown of the device then a latchup occurred and the proton fluence would be recorded. The primary concern with proton testing, outside the latchup, is the total dose the part receives during the testing. Previous

Cobalt-60 testing shows that the AD7664 has functional failure at approximately 25 krad. Any indications of latchup beyond 20 krad of proton dose would be considered suspect.

V. Results

Five Analog to Digital Converters were tested to measure the latchup cross section under the above conditions. No latchup events were seen in any of the five devices. All five devices were in the beam until total dose failure. This failure occurred at 21.7 ± 1.1 krad(Si).

VI. Summary

No proton-induced latchup events were observed for a total fluence of 1.8×10^{12} protons/cm² across all five devices tested. This implies a cross section for proton-induced latchup of less than 6×10^{-13} cm².

VII. Recommendations

In general, devices are categorized based on heavy ion test data into one of the four following categories:

Category 1 – Recommended for usage in all NASA/GSFC spaceflight applications.

Category 2 – Recommended for usage in NASA/GSFC spaceflight applications, but may require mitigation techniques.

Category 3 – Recommended for usage in some NASA/GSFC spaceflight applications, but requires extensive mitigation techniques or hard failure recovery mode.

Category 4 – Not recommended for usage in any NASA/GSFC spaceflight applications.

While the AD7664 Analog Devices Analog to Digital Converters do not show any proton susceptibility to latchup, the heavy ion susceptibility still makes these devices Category 3 devices (or 4 if latent damage testing shows any latent damage from the heavy ion-induced latches).